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ABSTRACT

A taxonomy of response processes has been developed to facilitate the designing of training programs; each kind of task presumably would require a different set of training methods for greatest efficiency, so classifying a task would be part of determining which methods to use. A pool of response distinctions was collected, with special attention to those commonly made in training practice. A large number of training strategies were also collected and organized into a classification scheme. The two taxonomies were then systematically interrelated to further their development and application. (Author)

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The Development of a Response Taxonomy

by

Elmo E. Miller

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Prefatory Note

This paper was presented as part of a symposium entitled "Progress Towards a Taxonomy of Human Performance," at the American Psychological Association meeting by the author, Dr. Elmo E. Miller. The research reported in the paper was performed under Basic Research 8, Common Job Elements, at HumRRO Division No. 2, Fort Knox, Kentucky. The objective of the research is to provide a classification system for relating training methods to the types of job requirements with which they are most effective.

THE DEVELOPMENT OF A RESPONSE TAXONOMY

Elmo E. Miller

During the last few years, there has been increasing activity and interest in taxonomies of human performance. I want to share some of my experiences in developing one such taxonomy, with the hope that this may prove helpful to others involved in developing such systems.

My taxonomy is restricted to perceptual-motor skills—a term I have not attempted to define precisely. I have tried, rather, to set the limits broadly in order to include most of the tasks that are generally listed under this topic.

There is another restriction on my taxonomy: It was specifically designed to help in the design of training programs. Thus, if the taxonomy achieves its purpose, each category of tasks would call for a different set of training strategies.

As to the performance being classified, I am concerned with the functions, or operations, which a person must perform in a system, such as a man-machine system, rather than with internal processes. I will stress the approach I followed, so as to help those who are trying to decide whether to follow a similar approach.

First, my approach was *not* experimental, at least not directly. I did not begin by designing and performing experiments. It seemed that a comprehensive taxonomy would require far more resources than I could muster. Instead, I collected a large body of task distinctions and other considerations, from both the experimental literature and common observation, and tried to form these into a system by a process of *explication*—that is, by systematically developing the interrelationships among the terms.

The fruitfulness of this approach increases sharply with the number (in this case, several hundred) and variety of items considered.

In order to extract relationships, I used a technique that I call "connotative clustering." This is simply listing the terms, then copying them, one by one, on a large sheet of paper, placing each new term near other terms that are most similar in their connotations. As more terms are added, clusters of related terms seem to emerge, and it becomes relatively easy to define the clusters and their interrelations. I suppose that there are many similar devices for listing, then juggling and shuffling terms. The important thing, when dealing with such complex and abstract relationships, is to have some effective means of structuring one's activities, so as to evolve an increasingly coherent logical structure.

A second major feature of the approach is the development of a second taxonomy—a taxonomy of training strategies. Since our purpose in classifying tasks is to facilitate the use of training strategies, it seems only reasonable to try to formulate these strategies explicitly. Actually, the two taxonomies were developed concurrently and were frequently compared, so that the distinctions among tasks would tend to reflect differences in training strategies.

The training strategies are listed in Figure 1. The first section, A, "Operational Conditions of Practice," seems fairly traditional—such concerns as the practice environment, dividing the task for allocation into practice sessions, telling the person what he must do in the situation, and so forth.

However, the second section, B, "Diagnosis of the Behavioral Process," seems somewhat unusual for a psychologist. These seem to be the sorts of things commonly done by coaches. For example, look at 4, c, "Inducing set to avoid common mistakes." Specifically, in water skiing, a coach will say "When the boat first pulls you up out of the water, you'll tend to fall forward on your face, so lean way back." In this second group of training strategies, it may be dubious what the coach or instructor actually does, in behavioral terms. Most often, he only talks to the student, stating his diagnosis and leaving it to the student to adjust his responses accordingly.

In the taxonomy of response processes section (Figure 2), only the four major divisions are listed (the subdivisions were omitted in the interest of simplicity). In the "reactive" tasks, the performance stays fairly homogeneous over time. For example, if you observe a typist for five seconds, her performance will be essentially the same in character as it would be in another sample taken a few minutes later.

In the first category, Adjustive, the person must try to bring about an alignment in the stimulus dimension. A feedback loop is thus established so that what is not corrected at one moment will remain in the system for later correction. In the second category, however, in tasks like typing, if a mistake is made, it's like water over the dam—there is no way to modify the next response to make up for it. It's a difference in the nature of the feedback loop—and I believe this is the basic difference between what are usually called "continuous" tasks and "discrete" tasks.

The definition of Category II tasks requires that there be a series of conventional signs in the environment, such as letters or numbers, which specify the series of actions to be performed. If these signs are not apparent, as when a person composes as he types, then it is assumed that generating the symbols—that is, composing—is a separate task.

In performing tasks of the last two categories, the task functions *do* change in character during any particular performance of the task. Each performance goes through several phases—beginning, middle, and end. The third category, Procedural, includes the categorical or qualitative aspects of performance, and the last category covers the

Development of a Response Taxonomy

Training Strategies

A. Operational Conditions of Practice

1. Representation of the task environment
   a. Unmodified task environment
   b. Purposeful modification
      (1) Stimulus predifferentiation
         (a) Terminology practice
         (b) Progressive narrowing of discrimination
         (c) Demonstrating tolerance limits
         (d) Recalling differences
      (2) Response differentiation
         (a) Practicing at slower rate
            Task-paced Tasks
            Self-paced Tasks
         (b) Reducing force or amplitude required
         (c) Relaxing qualitative standards for responses
2. Analysis into subtasks
   a. Successive phases
   b. Concurrent subtasks
      (1) Independent subtasks
      (2) Interdependent subtasks
3. Performance requirements information (telling S what to do)
   a. Size of behavioral unit described
   b. Contingencies for prompting
      (1) Time in training
      (2) S's past performance
      (3) Properties of responses required
      (4) Speed of response
      (5) S's request for prompt
   c. Completeness of prompts
      (1) Cue (partial)
      (2) Prompt (complete)
4. Supplementary knowledge of results (KR)
   a. Size of response unit
      (1) KR after each step
      (2) KR after end result
         (a) General KR
         (b) KR specific to a particular step
   b. Form of KR
      (1) Providing comparison
      (2) Giving assessment
5. Manipulating incentives
   a. Adding incentives
   b. Emphasizing existing incentives

B. Diagnosis of the Behavioral Process

1. Promoting intrinsic KR
   a. Clarifying goal state
   b. Calling attention to subgoal images
   c. Providing supplementary KR
2. Fostering conception of underlying process
3. Establishing a more effective response set
   a. Promoting movement consistency for better feedback
   b. Establishing response set which permits sensing of feedback
4. Inducing set for appropriate response pattern
   a. Physically guiding responses
   b. Describing desired modifications of responses
   c. Inducing set to avoid common mistakes
   d. Instructing on grip or stance
5. Inducing cue sensitivity
   a. Signaling, during task performance, the moment for a response
   b. Describing situation which is to trigger the action
6. Encouraging anticipation of the response (reading ahead)

Figure 1

Task Taxonomy (Response Processes)

Major Task Category	Common Reference Terms: Examples
Reactive Tasks	
I. Adjustive	Tracking or adjusting: adjusting a knob, steering a car, stick control in flying a plane, steering a bicycle.
II. Selection from a set of responses	(No common reference term): Typing, sight reading in playing a piano.
Developmental Tasks	
III. Procedural	Procedures: aircraft flight procedures, procedure for assembling an M1 rifle, starting a tank.
IV. Skilled performance	Skilled act: batting a ball, throwing a ball, laying a single brick, a hand stand, vaulting over an obstacle.

Figure 2

quantitative, fine-skill aspects of performance. Learning procedures involves the chaining together of simple, already learned acts.

One can make reasonably sharp distinctions among tasks because of two very pervasive features of our culture: the use of machines, and the use of language. (The most primitive category is "Skilled performance," in which we find complex, subtle behavior developing toward an objective. Most athletic performance is of this sort.)

The combination of machines, which have identifiable parts, and language, which deals with the world in terms of categories, causes the emergence of procedural tasks. Also, with the complexity of our technology, we find it increasingly *useful* to form long chains of essentially simple acts, that is, procedures. These factors also affect the training strategy; the classic method for teaching procedures is to put the student into a reasonably realistic work situation (Training Strategy A,1,a) and then tell him what he is to do (some variation under A,3, such as prompting him before each step).

The use of machines also creates Category I, Adjustive tasks, such as tracking, for it is the machine that creates the requirement for maintaining a roughly optimal condition, and also provides the structure necessary for consistent dynamic properties. Category II, covering such tasks as typing and sending Morse code—is peculiarly dependent upon a series of conventional signs in the environment. Such tasks, in reality, are probably an information-processing kind of function which happens to keep the person busy on the effector side.

The two taxonomies, for tasks and for training strategies, were interrelated in detail, both during development and later in trying to assess how well they had accomplished their purposes.

For example, consider the training strategies B,1, a and b, which refer specifically to goal images and goal states. These would *not* refer to the "reactive" categories, I and II, because the reactive task functions are homogeneous over time, and hence do not involve development toward a goal. These strategies are often implied to tasks of type IV, Skilled performance. In such tasks, the image of the goal situation sets up a feedback loop with the current situation, to guide development toward the goal. These training strategies may also apply to procedural tasks, but in the somewhat more trivial sense of a mnemonic device, rather than forming a feedback loop.

As another example, consider B6 (reading ahead), the last training strategy listed. In the very literal definition of this strategy, there would have to be some signs in the environment that tell what future responses must be, thus allowing a person to organize his responses into larger units. Category II tasks are of this sort by definition, and in these tasks coaches or teachers do in fact encourage students to "read ahead," as in sight reading on the piano. In tracking tasks, Category I, however, one would have to be able to see the track ahead, as when driving along a road. Incidentally, this establishes subcategories of tracking tasks, on the basis of whether the person can see the track ahead. Of course, one could apply the training strategy in a somewhat different version—that is, "imagine the track ahead." However, the effectiveness of this modified strategy would be limited by the degree of coherence, or autocorrelation, in the task. Similarly, the "read ahead" strategy would *not* apply to "procedural" tasks or "skilled performance" tasks, except in situations where extensive job aids were used.

In summary, the taxonomy of perceptual-motor tasks was developed by *explication* from existing concepts, rather than through experiments. The project also involved developing another taxonomy, that of training strategies, so that the development could reflect its purpose—more effective use of the training strategies. The major task categories depend upon the prevalence in our society of machines and language. The effort seems to offer some encouragement for further development of taxonomies of human performance.

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